

FIG. 1

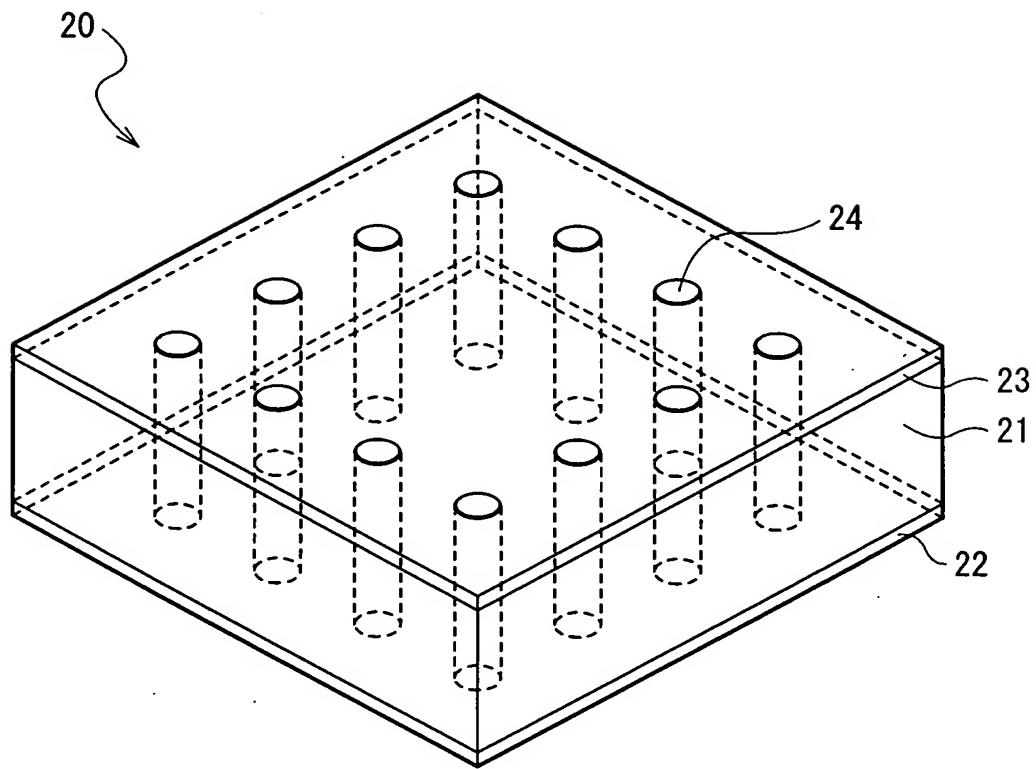


FIG. 2

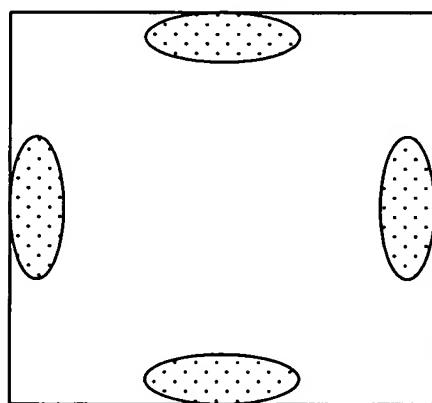


FIG. 3

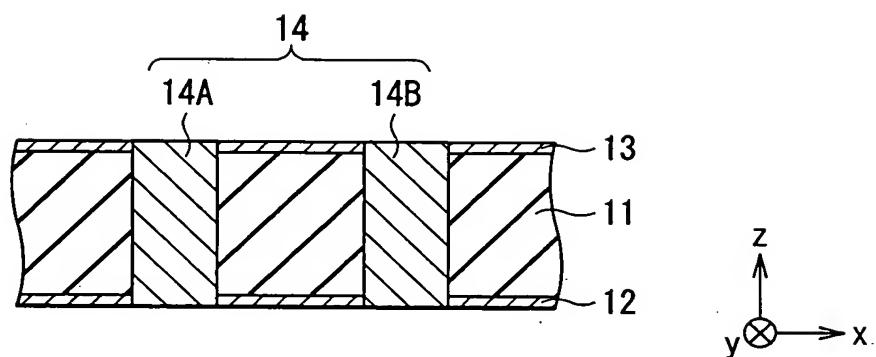


FIG. 4

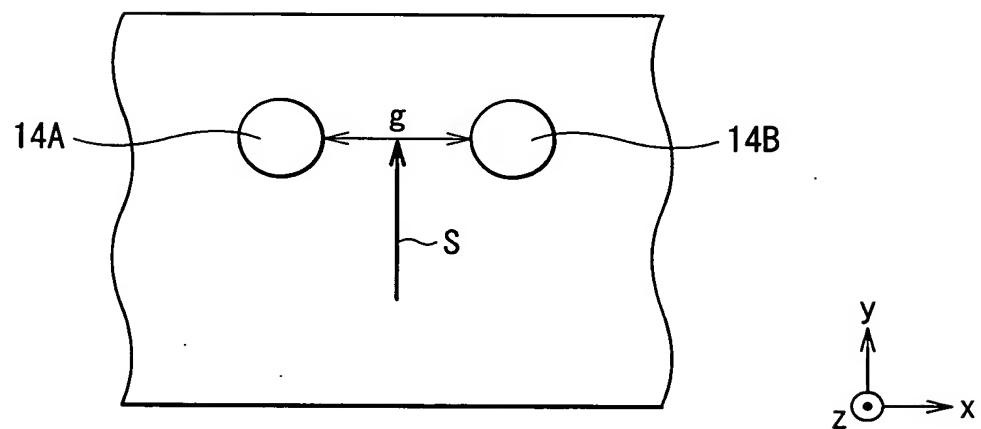


FIG. 5

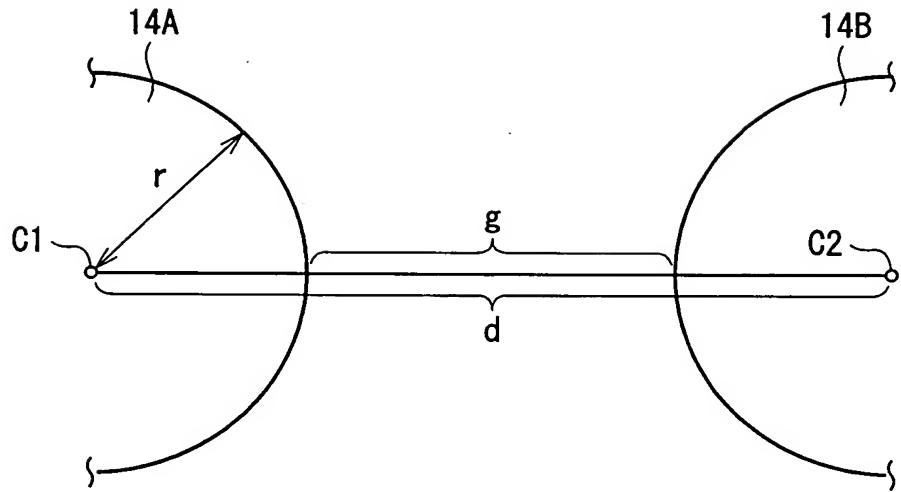


FIG. 6

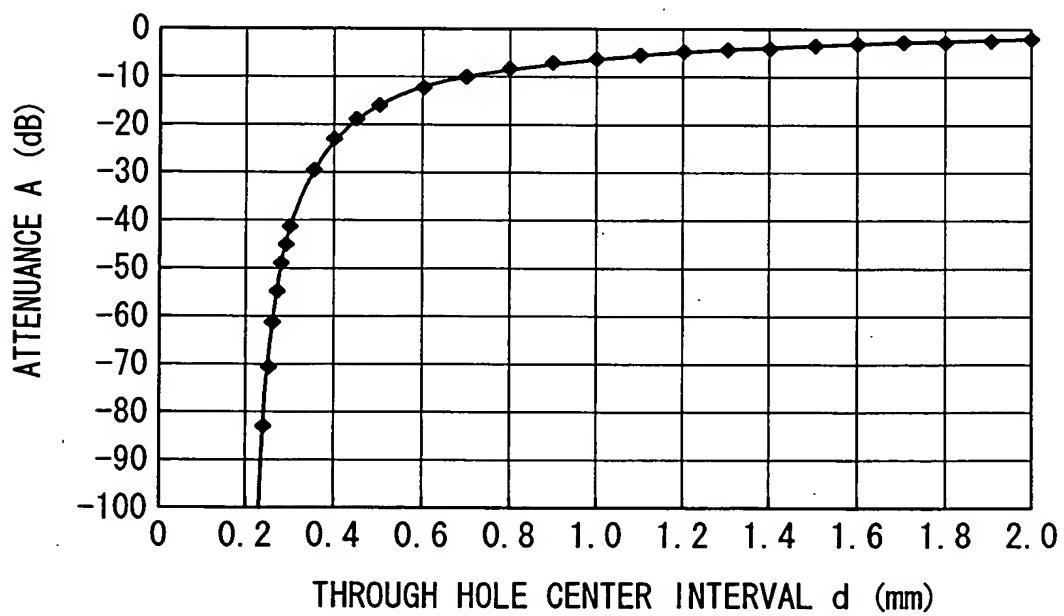


FIG. 7

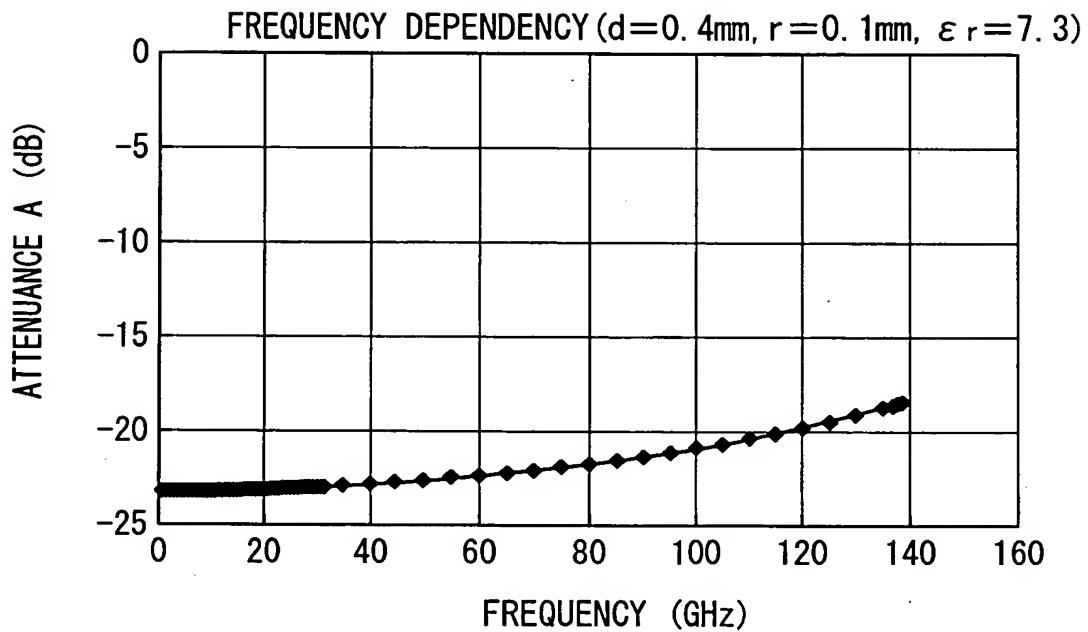


FIG. 8

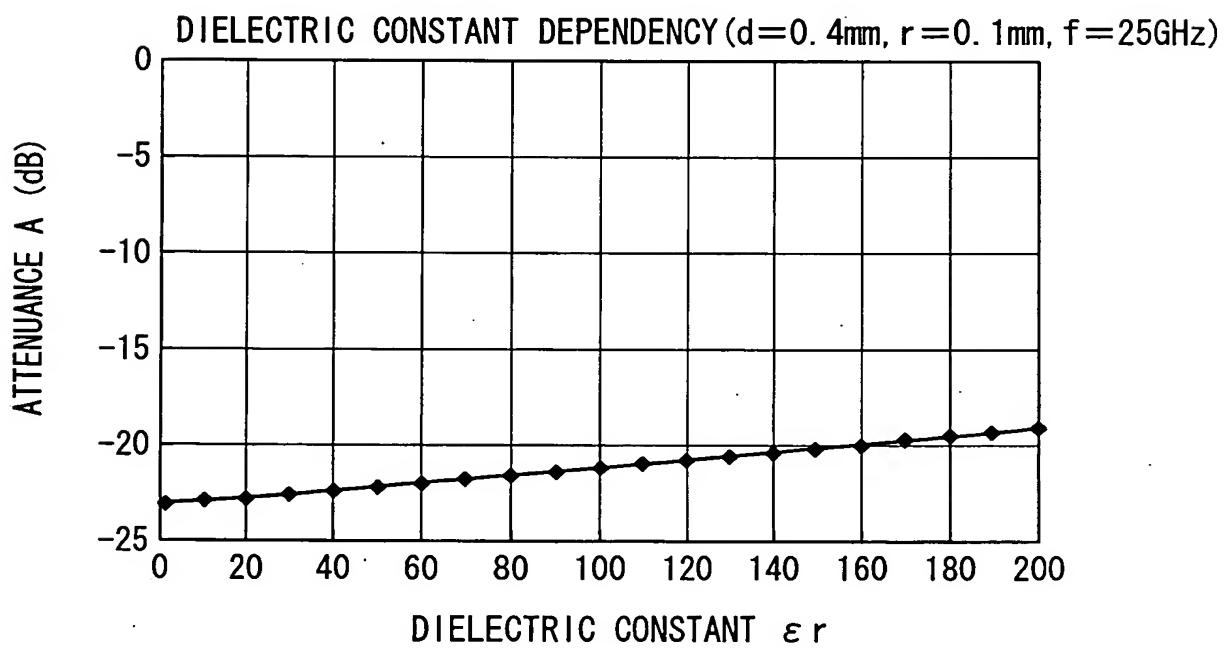


FIG. 9

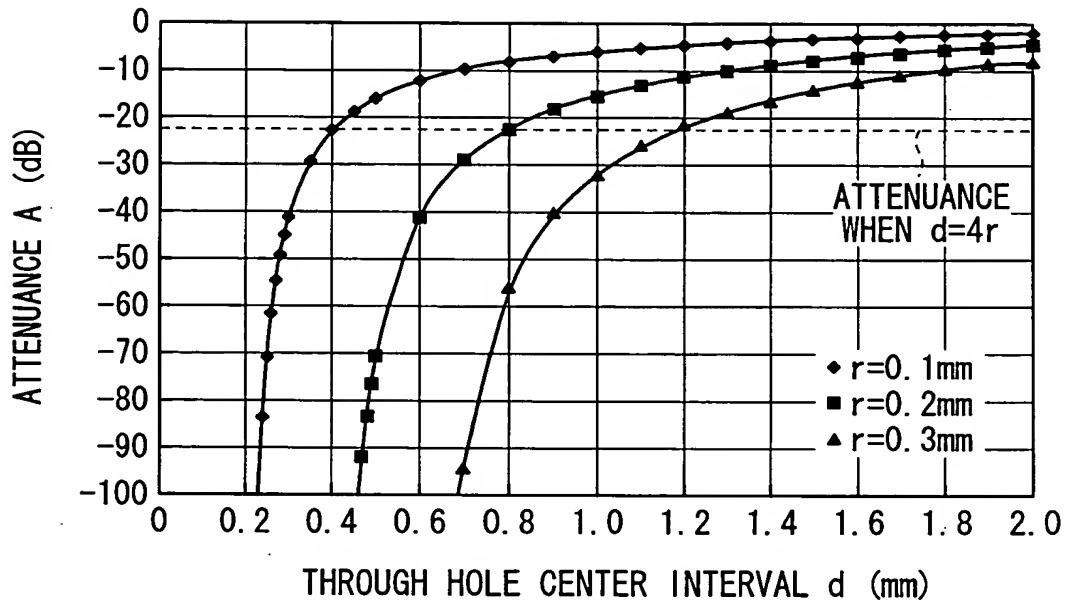


FIG. 10

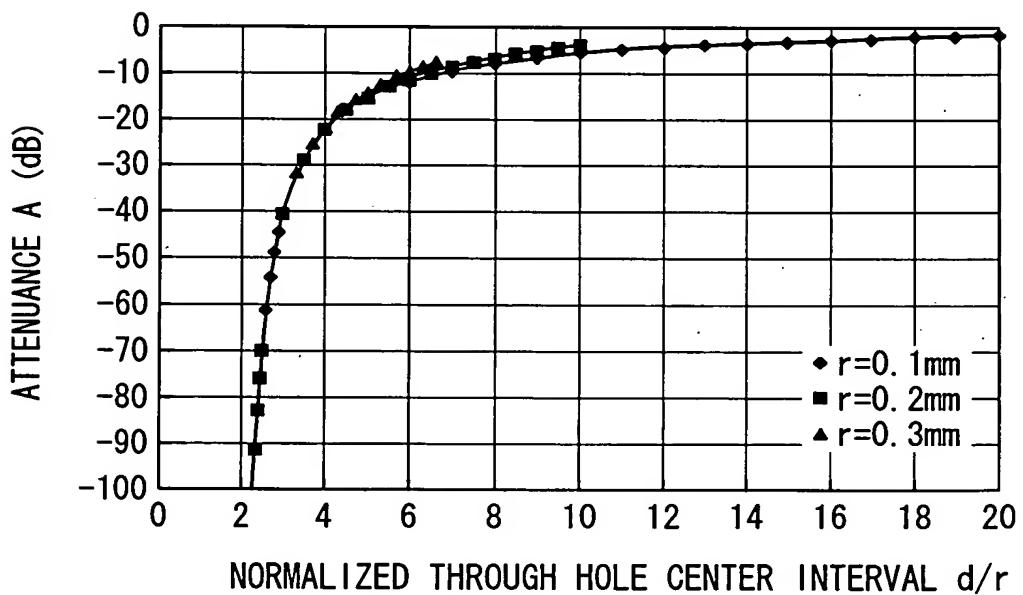


FIG. 11

FIG. 12A case 1

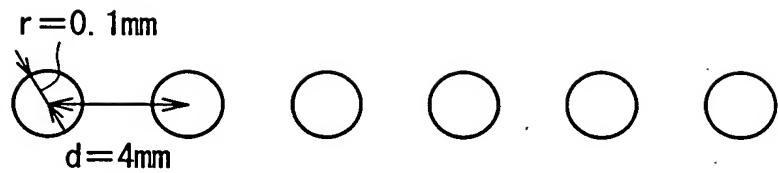


FIG. 12B case 2

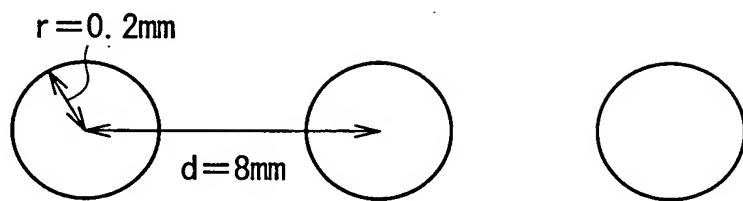


FIG. 12C case 3

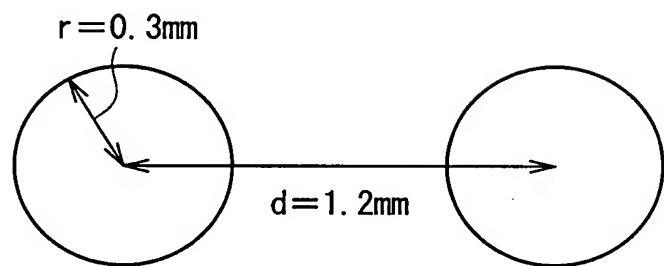
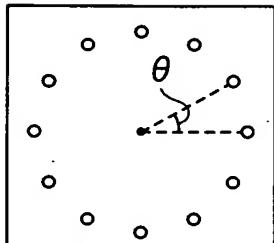
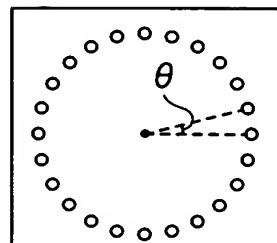


FIG. 13A



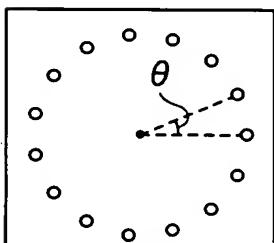
$$\theta = 30^\circ$$

FIG. 13E



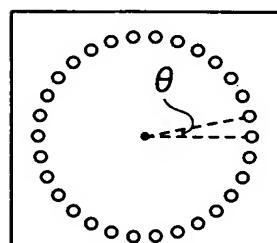
$$\theta = 15^\circ$$

FIG. 13B



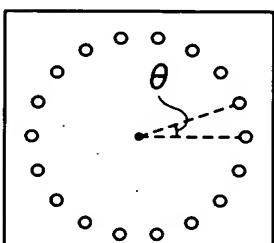
$$\theta = 24^\circ$$

FIG. 13F



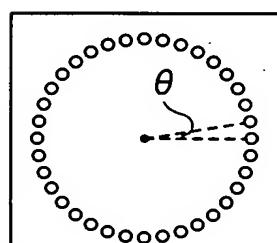
$$\theta = 12^\circ$$

FIG. 13C



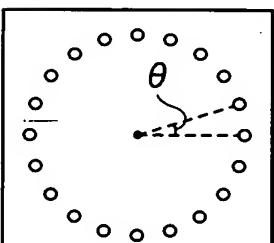
$$\theta = 20^\circ$$

FIG. 13G



$$\theta = 10^\circ$$

FIG. 13D



$$\theta = 18^\circ$$

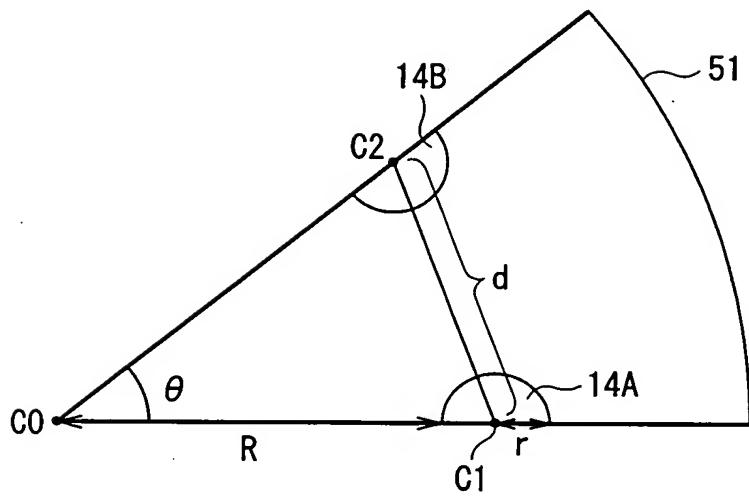


FIG. 14

FIG. 15A

THROUGH HOLE RADIUS  $r=0.1\text{mm}$  RESONATOR THICKNESS  $h=0.2\text{mm}$ 

$\theta$ (degree)	f (GHz)	Q	fr (GHz)	Qr	d (mm)	A (dB)
30	22.99	275.10	22.87	20.66	0.90	-6.95
24	23.55	283.02	23.51	63.97	0.73	-9.22
20	23.89	289.16	23.88	146.49	0.62	-11.75
18	24.05	291.62	24.04	200.22	0.56	-13.60
15	24.27	294.96	24.27	273.15	0.47	-17.83
12	24.47	298.87	24.47	296.69	0.37	-25.93
10	24.59	300.99	24.59	300.97	0.31	-37.48
CYLINDER (THEORETICAL) VALUE	24.98	307.80	24.98	307.80		

FIG. 15B

THROUGH HOLE RADIUS  $r=0.1\text{mm}$  RESONATOR THICKNESS  $h=0.3\text{mm}$ 

$\theta$ (degree)	f (GHz)	Q	fr (GHz)	Qr	d (mm)	A (dB)
30	23.00	379.75	22.89	21.06	0.90	-6.95
24	23.56	393.95	23.53	68.68	0.73	-9.22
20	23.90	403.31	23.89	167.71	0.62	-11.75
18	24.06	407.36	24.05	249.22	0.56	-13.60
15	24.28	414.80	24.28	368.46	0.47	-17.83
12	24.48	421.00	24.48	418.58	0.37	-25.93
10	24.60	425.28	24.60	425.54	0.31	-37.48
CYLINDER (THEORETICAL) VALUE	24.98	438.62	24.98	438.62		

FIG. 15C

THROUGH HOLE RADIUS  $r=0.1\text{mm}$  RESONATOR THICKNESS  $h=0.4\text{mm}$ 

$\theta$ (degree)	f (GHz)	Q	fr (GHz)	Qr	d (mm)	A (dB)
30	23.01	469.69	22.89	21.38	0.90	-6.95
24	23.56	490.35	23.53	70.88	0.73	-9.22
20	23.91	504.42	23.90	181.17	0.62	-11.75
18	24.07	510.85	24.06	280.23	0.56	-13.60
15	24.29	520.06	24.29	451.90	0.47	-17.83
12	24.49	531.07	24.49	525.72	0.37	-25.93
10	24.61	535.10	24.61	528.15	0.31	-37.48
CYLINDER (THEORETICAL) VALUE	24.98	556.98	24.98	556.98		

$\theta$ (degree)	r/d
30	0. 0556
24	0. 0683
20	0. 0812
18	0. 0899
15	0. 1073
12	0. 1336
10	0. 1600

FIG. 16

$\theta$ (degree)		
r=0. 1mm	r=0. 2mm	r=0. 3mm
30. 00	58. 73	88. 66
24. 00	46. 40	68. 30
20. 00	38. 42	55. 92
18. 00	34. 48	49. 97
15. 00	28. 64	41. 27
12. 00	22. 85	32. 79
10. 00	19. 01	27. 22

FIG. 17

FIG. 18A

THROUGH HOLE RADIUS  $r=0.2\text{mm}$  RESONATOR THICKNESS  $h=0.2\text{mm}$ 

$\theta$ (degree)	f (GHz)	Q	fr (GHz)	Qr	d (mm)	A (dB)
58. 73296	21. 19	268. 55	20. 14	13. 27	1. 62	-6. 76
46. 39951	22. 24	276. 90	21. 91	34. 90	1. 38	-9. 09
38. 41832	22. 91	283. 48	22. 81	92. 58	1. 18	-11. 72
34. 48327	23. 22	286. 83	23. 17	151. 70	1. 08	-13. 64
28. 63711	23. 65	291. 86	23. 65	252. 02	0. 91	-17. 99
22. 84636	24. 04	296. 54	24. 04	293. 00	0. 74	-26. 29
19. 01041	24. 27	299. 26	24. 27	299. 15	0. 62	-38. 10
CYLINDER (THEORETICAL) VALUE	24. 98	307. 80	24. 98	307. 80		

FIG. 18B

THROUGH HOLE RADIUS  $r=0.2\text{mm}$  RESONATOR THICKNESS  $h=0.3\text{mm}$ 

$\theta$ (degree)	f (GHz)	Q	fr (GHz)	Qr	d (mm)	A (dB)
58. 73296	21. 20	373. 42	20. 15	13. 44	1. 62	-6. 76
46. 39951	22. 25	385. 89	21. 92	36. 17	1. 38	-9. 09
38. 41832	22. 92	396. 71	22. 82	102. 00	1. 18	-11. 72
34. 48327	23. 23	402. 40	23. 19	178. 75	1. 08	-13. 64
28. 63711	23. 67	410. 76	23. 66	335. 74	0. 91	-17. 99
22. 84636	24. 05	417. 45	24. 05	412. 84	0. 74	-26. 29
19. 01041	24. 29	423. 34	24. 28	422. 97	0. 62	-38. 10
CYLINDER (THEORETICAL) VALUE	24. 98	438. 62	24. 98	438. 62		

FIG. 18C

THROUGH HOLE RADIUS  $r=0.2\text{mm}$  RESONATOR THICKNESS  $h=0.4\text{mm}$ 

$\theta$ (degree)	f (GHz)	Q	fr (GHz)	Qr	d (mm)	A (dB)
58. 73296	21. 21	463. 75	20. 15	13. 53	1. 62	-6. 76
46. 39951	22. 26	480. 94	21. 93	36. 84	1. 38	-9. 09
38. 41832	22. 92	495. 16	22. 82	107. 45	1. 18	-11. 72
34. 48327	23. 24	503. 41	23. 19	195. 99	1. 08	-13. 64
28. 63711	23. 67	515. 04	23. 66	401. 13	0. 91	-17. 99
22. 84636	24. 06	525. 97	24. 06	518. 37	0. 74	-26. 29
19. 01041	24. 29	533. 65	24. 29	533. 29	0. 62	-38. 10
CYLINDER (THEORETICAL) VALUE	24. 98	556. 98	24. 98	556. 98		

FIG. 19A

THROUGH HOLE RADIUS  $r=0.3\text{mm}$  RESONATOR THICKNESS  $h=0.2\text{mm}$ 

$\theta$ (degree)	f (GHz)	Q	fr (GHz)	Qr	d (mm)	A (dB)
88. 6634	19. 55	263. 96	17. 35	9. 15	2. 00	-7. 82
68. 3	20. 96	271. 49	20. 13	22. 08	1. 86	-9. 30
55. 9194	21. 94	278. 34	21. 68	64. 30	1. 66	-11. 83
49. 969	22. 41	282. 28	22. 30	119. 23	1. 53	-13. 78
41. 2709	23. 07	288. 40	23. 05	236. 72	1. 32	-18. 26
32. 7863	23. 65	294. 21	23. 64	290. 88	1. 08	-26. 83
27. 221	23. 98	297. 63	23. 98	297. 54	0. 91	-39. 03
CYLINDER (THEORETICAL) VALUE	24. 98	307. 80	24. 98	307. 80		

FIG. 19B

THROUGH HOLE RADIUS  $r=0.3\text{mm}$  RESONATOR THICKNESS  $h=0.3\text{mm}$ 

$\theta$ (degree)	f (GHz)	Q	fr (GHz)	Qr	d (mm)	A (dB)
88. 6634	19. 57	370. 59	17. 36	9. 24	2. 00	-7. 82
68. 3	20. 98	379. 74	20. 14	22. 60	1. 86	-9. 30
55. 9194	21. 95	389. 69	21. 69	68. 81	1. 66	-11. 83
49. 969	22. 42	396. 14	22. 31	135. 62	1. 53	-13. 78
41. 2709	23. 08	405. 82	23. 06	309. 52	1. 32	-18. 26
32. 7863	23. 66	415. 29	23. 66	408. 82	1. 08	-26. 83
27. 221	23. 99	419. 58	23. 99	420. 83	0. 91	-39. 03
CYLINDER (THEORETICAL) VALUE	24. 98	438. 62	24. 98	438. 62		

FIG. 19C

THROUGH HOLE RADIUS  $r=0.3\text{mm}$  RESONATOR THICKNESS  $h=0.4\text{mm}$ 

$\theta$ (degree)	f (GHz)	Q	fr (GHz)	Qr	d (mm)	A (dB)
88. 6634	19. 57	464. 32	17. 36	9. 29	2. 00	-7. 82
68. 3	20. 98	474. 38	20. 14	22. 87	1. 86	-9. 30
55. 9194	21. 95	488. 31	21. 69	71. 34	1. 66	-11. 83
49. 969	22. 43	496. 31	22. 31	145. 64	1. 53	-13. 78
41. 2709	23. 09	509. 64	23. 07	367. 81	1. 32	-18. 26
32. 7863	23. 66	522. 94	23. 66	513. 03	1. 08	-26. 83
27. 221	24. 00	531. 38	24. 06	531. 37	0. 91	-39. 03
CYLINDER (THEORETICAL) VALUE	24. 98	556. 98	24. 98	556. 98		

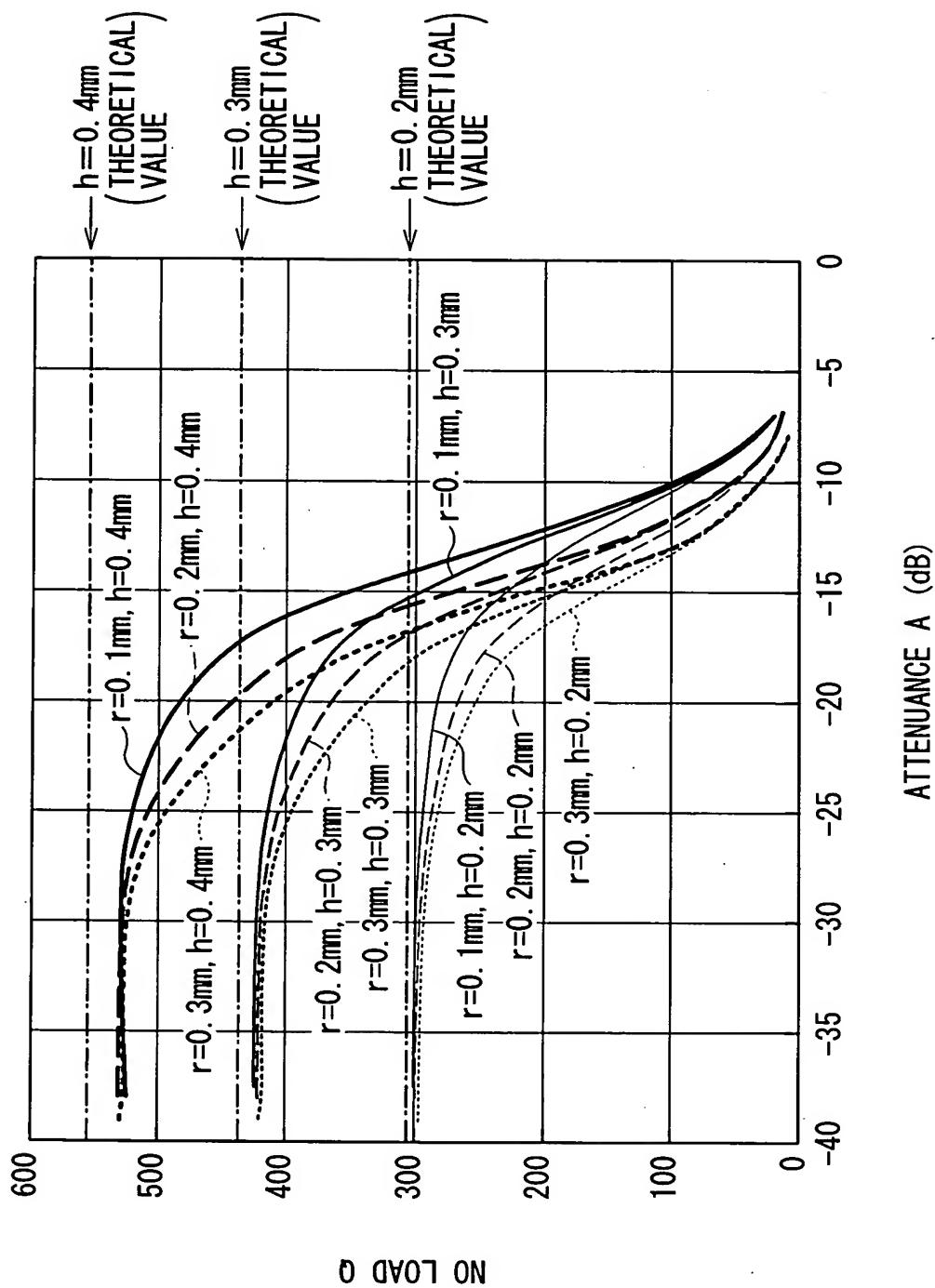


FIG. 20

FIG. 21A  $r=0.1\text{mm}$

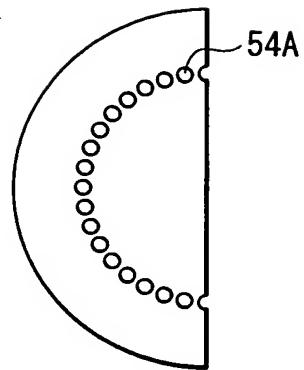


FIG. 21B  $r=0.2\text{mm}$

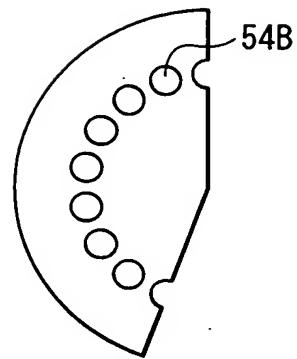


FIG. 21C  $r=0.3\text{mm}$

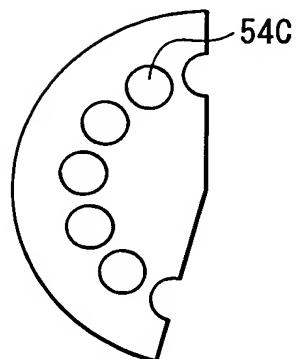


FIG. 22A  $r=0.1\text{mm}$

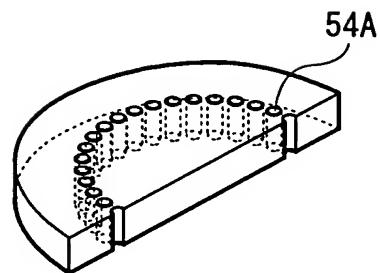


FIG. 22B  $r=0.2\text{mm}$

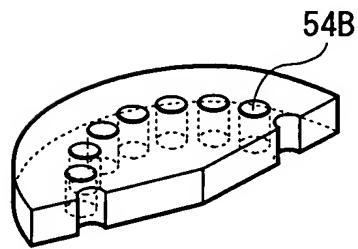


FIG. 22C  $r=0.3\text{mm}$

